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Ultrasonics and electromagnetic control of rodents

W.E. Howard & R.E. Marsh

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The efficaciousness of ultrasound (above 20 kHz) and of electromagnetic devices for rodent control is reviewed. It is well established that such devices will not exterminate, kill, or drive rodents out of a favorable habitat. At best they may temporarily discourage rodents from visiting areas in buildings that have little cover available or prevent rodents from entering open doorways. However, based on any known scientific data, conventional control methods still seem to be more cost-effective than ultrasonics.

W.E. Howard & R.E. Marsh, Wildlife and Fisheries Biology, University of California, Davis, California 95616.

1. Introduction

Scientists have long searched for nonchemical means of controlling rats (*Rattus* spp.), mice (*Mus* spp.), and other pest rodents. Advances have been achieved by applying better rodent-proofing practices and improving sanitation, whereas the use of predators, objectionable odors, and repellent sounds has not been very satisfactory.

There is no question that rats and mice are capable of emitting and receiving ultrasonic sounds, i.e. frequencies above 20 kHz (Anderson 1954, Noirot 1972, Bell et al. 1974, Brown 1976, Brewster & Leon 1980). Hence, many ultrasound devices have been marketed claiming they will rid the premise of rats and mice. A number of tests have been conducted to evaluate the effectiveness of ultrasound as a rodent deterrent (Marsh et al. 1962, Sprock et al. 1967, Greaves & Rowe 1969, Pinel 1972, Meehan 1976, Lavoie & Glahn 1977, Jackson 1980, Shumake et al. 1982).

2. Test results

2.1. Ultrasonic devices

Late in the 1950s, one of us (Howard) started evaluating the effectiveness of ultrasound produced by electric generators and of many other kinds of sounds of potential value (Sprock et al. 1967). At that time we tested biosonics, i.e., distress calls (the sounds emitted when a rat was caught and killed by a skunk), the frightening effect of intermittent and varied frequency of both audible and ultrasounds (4—48 kHz), audiogenic seizures from high intensity and other effects of intensities up to 140 db, food hoppers that were wired so as to activate oscillators of 6, 9 and 12 kHz whenever a rat fed at one of the hoppers, and a low-intensity burglar alarm acoustic device of about 19 kHz.

The conclusions of these tests were: 1) that audible sounds are more frightening to rats than ultrasonics; 2) rats habituate to even frightening sounds rather quickly; 3) the taped distress calls of a rat being killed by a skunk were the most frightening to rats of all sounds tested; 4) intermittent sounds varied through an entire octave (6—12 kHz) were more effective than when the frequency varied only half-octaves (6—9, 9—12, 12—16 kHz); 5) only under laboratory conditions could sound intensities be used that caused wild rats to die from epileptiform seizures; and 6) rats put into nonlethal seizures from being exposed to sounds ranging up to 25 kHz and above and at intenstities of 120—140 db were then unaffected by such sounds until after being rested from such exposure for a week or so.

Marsh et al. (1962) found ultrasound provided some repellency of rodents, but when the three elevators were checked 17 to 27 days later, the rodent movement (tracks) was the same as preinstallation patterns.

Greaves & Rowe (1969) concluded that "strategically placed ultrasound devices may prevent or reduce invasion by freemoving rodents of premises with few entry points." Meehan (1976) found that four commercial devices were of little effect in frightening rodents from specific feeding sites.

LaVoie & Glahn (1977) also showed in field tests that many rodents may habituate to ultrasounds in the field within a few weeks. After testing 5 commercial ultrasonic generators, with a wide range of frequencies, amplitudes, duty cycles, and pulse rates, they concluded that the aversive properties were not suffifient indoors or in the

field to keep rats away from food for very long.

Jackson (1980) reports that ultrasonic units in a chicken egg farm reduced rat ectivity and damage, but the impact was mitigated if abundant harborage was present.

Shumake et al. (1982) demonstrated in their laboratory tests with Philippine rats (*Rattus rattus mindanensis*), which were used because they quickly establish social hierarchies in a colony situation with minimal fighting, that "from a practical standpoint all ultrasonic rodent-repellent devices are quite limited in their effective range because the energy is quickly dissipated and does not normally reach occluded areas unless reflective surfaces are available." Even then they will not carry far.

Even though the experimental ultrasound devices used by Shumake et al. (1982) had frequencies of 20, 20—30, and 40 kHz, and produced peak outputs of 103, 116, and 118 db at 30 cm from the speakers in the small test chambers (1.95 m^3), no measurable ultrasound levels were detectable 30 cm from the chambers, even though each test chamber had two 10×10 cm entrances.

2.2. Electromagnetic devices

In recent years a number of electromagnetic pest control devices have been marketed and claimed to be effective in controlling rodents and other pest vertebrates and invertebrates. The characteristics of the output signals of commercial electromagnetic pest control devices consist of either a pulse output, with no significant external electromagnetic field, or a 60 Hz AC output that generates a detectable magnetic field. However, these fields at distances of 3 m or more are less than the earth's magnetic field.

With financial support from the U.S. Environmental Protection Agency, we conducted controlled tests concerning the efficacy of the principle of controlling rodents with electromagnetic devices (March & Howard 1980a,b,c). Others also tested various commercial electromagnetic rodent control devices (Caslick et al. 1977, Case et al. 1978, Byers 1979).

In all tests of electromagnetic devices tested, no efficacy could be detected where reasonable controls were included. Existing favorable reports are all "testimonials", that is, unsubstantiated evidence. It has been concluded that there was no scientific evidence that any known electromagnetic device works as advertised. As a result, EPA has now stopped the sale of such devices in the United States on the basis of false and misleading advertising (Conroy 1980).

3. Discussion

Theoretically, since rodents can hear ultrasounds, there may be situations where there is a temporary and limited fright response from ultrasound. However, most rats and other rodents quickly become accustomed to any new sound, especially after it has been repeated long enough. Consequently, rats and mice can be found living in grain mills, machine shops, around airports, along major highways, and many other places where the sound frequencies and levels of intensity are highly varied and complex. It seems that the behavior responses rodents display to ultrasounds is no different than their response to sounds within the hearing range of man. It even appears that sounds audible to man have a greater repellency to rats than do ultrasounds (Sprock et al. 1967), probably in part because the latter attenuate so rapidly in the environment.

When rodents are given a choice of feeding close to an ultrasonic device or at another location free of such stimuli, initially at least we would expect them to avoid the ultrasonic sounds. But to be effective in repelling rodents, entire warehouses must be kept in an unattenuated sound environment.

Even if some combination of intermittent ultrasound with variable frequency and intesity can be developed that is fairly frightening to rodents, it seems that it will still be difficult to develop ways of making this rodent-control approach economically practical in most stores, warehouses and other situations with rodent problems. The multiple unit or speaker concept is expensive and does not resolve the problems of environmental attenuation of such sounds. Unfortunately, we cannot visualize industrial situations where, including the cost of labor and ultrasonic devices, that ultrasound would be more cost-effective than conventional control methods and better rodent-proofing and sanitation.

What is needed is research designed to identify those limited situations where ultrasonic devices can be used advantageously and practically to reduce rodent problems, even if it is only a reduction in the rate of reinvasion. To resolve these questions, it will probably be necessary to use radio telemetry to follow the movements of transmittered rodents in a variety of situations, with and without ultrasonic devices being activated.

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